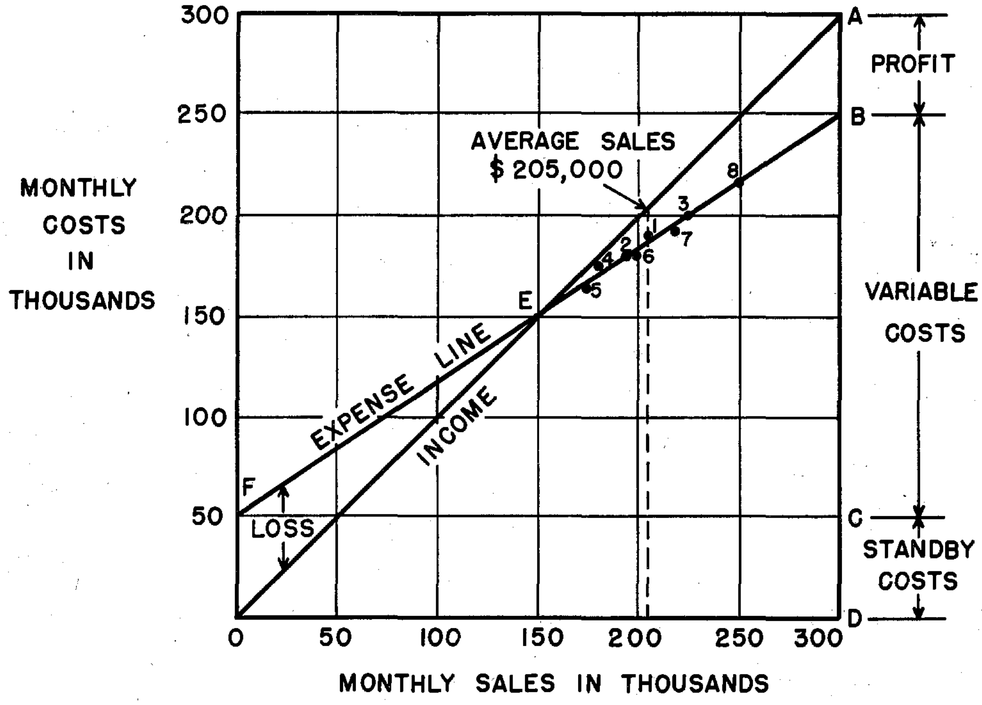
PROFIT ENGINEERING



The Break Even Chart: An Effective Management Tool for Improving Profits

by

ROBERT J. BARRY

HOW CAN THE PROFIT POTENTIAL of a business be given the same objective engineering study as the design of the product? The question constantly confronts business executives as they resolve business plans that are expected to influence profit.

There exists one remarkably effective method for showing management the summary effects on profit of changes in pricing, costs and sales volume. It is known as the break-even chart, or occasionally as the variable budget or profitgraph. Though it was first developed in 1910 by C. E. Knoeppel, it is being applied in very few organizations today—and in some it is scarcely known at all. But in recent years the break-even chart has been proving its effectiveness over and over again. More important, the application of this profit-planning analysis is helping to bridge the wide gap that has existed between the professions of finance and industrial engineering.

The first step in a profit-planning analysis is to determine the current relationship of profits, sales and costs for an enterprise. Typical sales and cost figures for one organization are shown below:

	Month	Sales Dollars	Costs Dollars	Net Profit Dollars (Before Income Taxes)
1	Jan.	205,000	190,000	15,000
2	Feb.	192,000	180,000	12,000
3	Mar.	225,000	200,000	25,000
4	Apr.	180,000	175,000	5,000
5	May	175,000	165,000	10,000
6	June	200,000	180,000	20,000
7	July	217,000	193,000	24,000
8	Aug.	250,000	215,000	35,000
TOTAL		1,644,000	1,498,000	146,000
AVERAGE		205,500	187,250	18,250

These figures—which show profits normally rising with increasing sales and dropping with decreasing sales—are then plotted on a break-even chart (above). Here, the horizontal scale represents sales volume, and the vertical scale represents costs. Both sales and costs are plotted to the same unit of measure.

Monthly cost figures follow a trend (line FB), intersecting the zero sales line (0) at $50,000 (point F). Minor variations in expense charges from month to month cause the departures from a straight line, which is the usual case unless there have been significant changes in sales, prices or costs. A 45° line drawn upward from O represents income, since costs and sales are plotted to the same unit of measure ($50,000 per inch in this case).

The normal profit or loss can now be determined by subtracting the expense intercept from the revenue intercept at the particular sales volume. For example, at sales of $300,000, normal expenses would be $250,000, and the profit $50,000.

The intersection of the revenue line with the expense line (point E, or $150,000) locates the sales volume point at which expenses equal sales. This is the break-even point. When sales exceed this point, there will be a profit; when sales fall below it, there will be a loss.

When the horizontal line FC is drawn, it is evident that there are two classes or basic types of costs making up the expense total—standby expenses and variable expenses. The standby costs (FO, or $50,000) are of the nature of real estate taxes, depreciation, rental costs, etc. They vary with time, but are not affected by the volume of sales. Variable costs include direct material, direct labor, sales commissions, etc., and vary directly with the sales volume. Variable costs at sales of $300,000 are $200,000 (BC).

Although many costs such as indirect labor and supervision increase with sales, but not in direct relationship, they can be broken down into variable and standby elements. These costs are called semi-variable. An example is shown at the bottom of this page.

The break-even chart summarizes all standby, variable and semivariable costs on one picture.

In our typical example fixed costs were identified as $50,000 per month. The relationship of variable costs to sales is $\frac{BC}{FC} = \frac{200}{300}$ or 66 2/3%. We now have the basic information to determine the algebraic relationship between profit, sales volume and costs.

$$\begin{aligned}
\text{Let } S &= \text{Sales volume} \\
V &= \text{Ratio of variable costs to sales} \\
F &= \text{Standby costs} \\
P &= \text{Profit (or loss)} \\
S &= P + F + VS \\
P &= S - VS - F \quad = S(1-V)-F \\
P &= S(1-V)-F
\end{aligned}$$

For a sales volume of $200,000, the Profit (P) would be:

$$\begin{aligned}
P &= \$200{,}000\ (1-.66\ 2/3) - \$50{,}000 \\
&= \$\ 16{,}667
\end{aligned}$$

We can also determine the break-even point by the fact that P = O and solve for Sales (S)

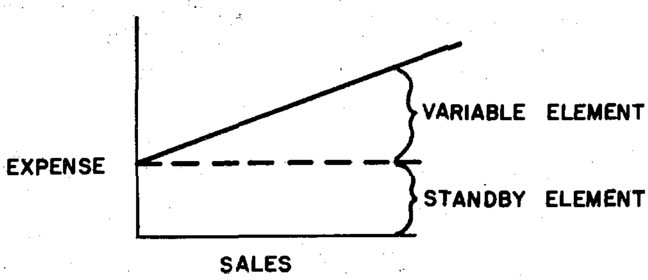
$$\begin{aligned}
O &= S(1-V)-F \\
S &= \frac{F}{1-V} = \frac{50{,}000}{(1-.66\ 2/3)} = \$150{,}000
\end{aligned}$$

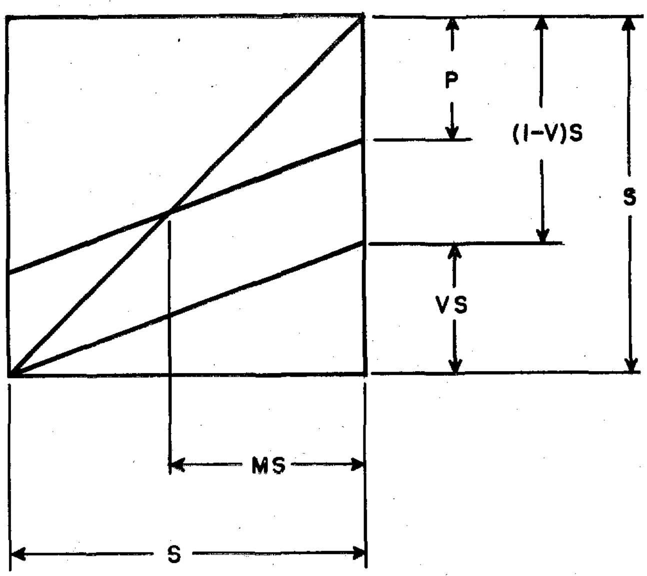
The sales required to obtain a profit of $40,000 can also be determined:

$$\begin{aligned}
40{,}000 &= S(1-.66\ 2/3) - 50{,}000 \\
S &= \frac{90{,}000}{.333} = \$270{,}000
\end{aligned}$$

Margin of Safety

In our typical case, the average sales were $205,000 per month, which is only $55,000 above the break-even point. It is obvious that a company that has a high break-even point in relation to sales will quickly turn from profit to loss when sales drop off. The profit strength of a company is directly proportional to the distance between present sales and the break-even point. This distance, expressed as a percentage of sales, is called the Margin of Safety. In our example the margin of safety is $\frac{55}{205} = 26.8\%$. Two companies may have the same percentage of net profit to sales at present volume but one company may withstand a much more severe drop in sales without loss because of its higher margin of safety.





The margin of safety directly influences the net profit, as shown at the top of this page.

$$\begin{aligned}
\text{Let } M &= \text{Margin of safety as \% of sales.} \\
\text{Then } \frac{P}{MS} &= \frac{(1-V)S}{S} \quad \text{(from the break-even chart on page 7)} \\
\text{(Net Profit) } \frac{P}{S} &= M(1-V)
\end{aligned}$$

or

The Net Profit percent $\frac{P}{S}$ is equal to the Margin of Safety times the Complement of the variable costs factor.

FACTORS THAT INFLUENCE PROFITS

There are five basic steps that can be taken to improve net profits:

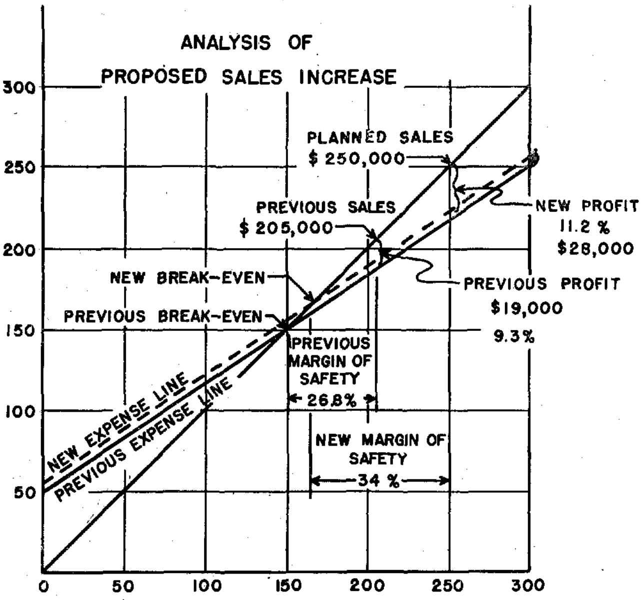
1. Increase sales
2. Reduce standby costs
3. Reduce variable costs
4. Raise prices
5. Change the sales mix

In our example, it was assumed that factors 2, 3, 4, and 5 did not change during the period covered by the study.

Increasing Sales

1. Obviously sales should be increased as a first step if the organization has the facilities and market to absorb the additional volume. Management may feel that the company is already getting its economical limit of sales in the industry or that its plant capacity has already been reached. However each possibility should be objectively appraised for its summary contribution to profits.

For example, the sales manager advises management to increase sales $45,000, but this would call for an



additional $5,000 per month for sales promotion, trucks, warehouses, etc.—which we will assume are all standby charges over and above the normal expenses expected at that sales volume. The problem is to evaluate this proposal on its profitability. The analysis, projected on the break-even chart (see chart above), shows that the proposal would be profitable, increasing the net profit from $19,000 (9.3%) to $28,000 (11.2%) and increasing the safety factor from 26.8% to 34.0%. However, since the break-even point is increased from $150,000 to $165,000, the company will need a definite assurance that the sales volume can be held in the range of $250,000 per month for an extended period.

Reducing Standard Costs

2. Each reduction of standby costs adds an equal amount to profit when other factors, including sales, are constant. Therefore the profit picture could be considerably improved in our example by reducing the standby costs 15% ($7,500) as shown in the chart at the right.

This step would not only increase the net profit to $26,500 (12.9%) but increase the margin of safety from 26.8% to 36.6% and lower the break-even point from $150,000 per month to $130,000. It is therefore evident that reduction of standby costs is an effective and direct method of improving the profit potential.

Reducing Variable Costs

3. Any decrease in the variable cost ratio to sales will of course reduce and improve the break-even point and increase the net profit where sales are above this break-even point. Some of the more significant methods of reducing this variable cost:

a. Redesign of the product to reduce material and labor costs.
b. Substitution of less expensive materials, and the appraisal of purchasing costs, discount rates and freight rates.
c. Methods improvements in shop and office to reduce the direct and indirect labor required.
d. Standardization of methods and procedures.
e. Use of wage incentives and/or profit-sharing to improve productivity and reduce labor costs.

The chart on p. 10 shows how the profit potential would be improved by a reduction of 10% in variable costs. The profit would increase to $32,000 from its former $19,000 and the margin of safety would become 39%, indicating that the reduction of variable costs is another way to strengthen the profit picture.

Raising Prices

4. Naturally it is a sound move to increase prices if the number of units sold remains constant, because this would have an effect similar to that of reducing variable costs with respect to sales. However, increasing prices usually reduces the number of units sold and the problem is to determine the most profitable price-volume relationship. As an example, suppose sales management has made a thorough study of the market and advises management that it can sell the following units at different price levels:

Selling price/unit	Number of units that can be sold	Total Sales
$20.50 (present price)	10,000	$205,000
22.50	8,500	192,000
25.00	6,000	150,000
30.00	4,000	120,000

In the analysis of the present cost structure it is already known that the standby costs are $50,000 and the variable costs are 66 2/3% or $13.70 per unit. (We will assume that variable costs remain at this figure.)

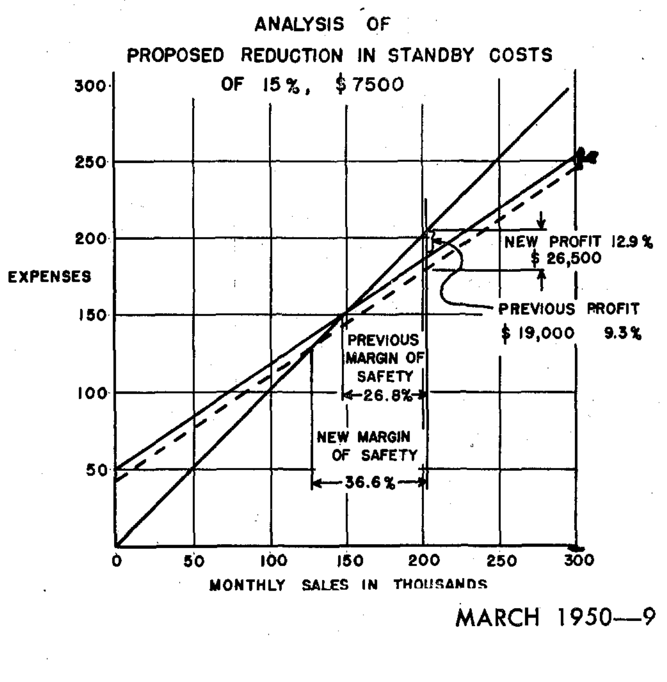
$$\text{Since } P = S(1-V)-F$$

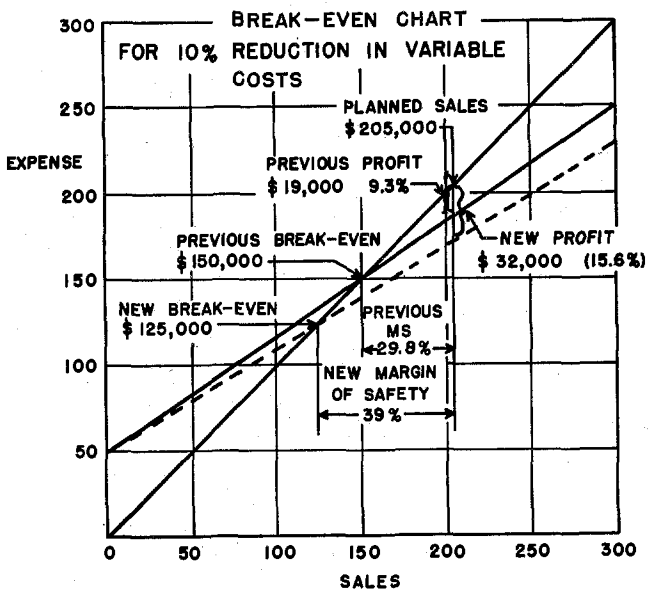
$$P20.50 = \$\ 19{,}000 \text{ from previous example}$$

$$P(22.50) = (192{,}000)\left(1-\frac{13.70}{22.50}\right) - 50{,}000 = \$24{,}500$$

$$P25.00 = (150{,}000)\left(1-\frac{13.70}{25.00}\right) - 50{,}000 = \$17{,}500$$

$$P30.00 = (120{,}000)\left(1-\frac{13.70}{30.00}\right) - 50{,}000 = \$14{,}400$$





It is therefore recommended that the price be increased to \$22.50 per unit, reducing total sales to \$192,000 per month but increasing the profit to \$24,500 or 12.8%, since this price-volume relation gives the best net profit.

Changing the Sales Mix

5. In many organizations the problem is complicated by the number of different products that are sold. In this case the solution is to break down the costs to products and determine the most profitable mix or percentage sales of each product. If the products are too numerous, they may be grouped in classes or divisions for study and analysis.

For example, the \$205,000 sales program may consist of three products, A, B, and C.

	Sales Dollars	Standby Cost Dollars	Variable Cost Dollars	Variable Percent	Net Profit Dollars	Net Profit %
A	\$100,000	\$20,000	\$ 72,000	72 %	\$ 8,000	8 %
B	75,000	20,000	49,000	65.5	6,000	8
C	30,000	10,000	15,000	50	5,000	16.7
TOTAL	\$205,000	\$50,000	\$136,000	66⅔ %	\$19,000	9.3%

We will assume in this case that total sales cannot be increased, that all possible cost reductions in both variable and standby costs have been made, and that prices cannot be changed.

Since Product C has the least (50%) variable cost per sales dollar, compared to A (72%) and B (65.5%) it is evident that any shift of sales from A or B to C will add to net profit. For example, by holding total sales constant but changing the sales mix, as below, an increase of \$5,800 is obtained.

	Sales	Standby Dollars	Variable Dollars	Variable Percent	Net Profit	Net Profit %
A	\$ 80,000	\$20,000	\$ 57,600	72 %	\$ 2,400	3 %
B	65,000	20,000	42,600	65.5	2,400	3.7
C	60,000	10,000	30,000	50	20,000	33
TOTAL	\$205,000	\$50,000	\$130,200	63.3%	\$24,800	12.1%

The adjustment of the sales mix as shown here is one of the least used yet most profitable steps a company can take in order to increase profits. In some cases, the total profit can be increased by dropping a product or replacing it with a product having a lower variable cost factor.

In practice, the steps taken to improve the profits and break-even point are usually a combination of two or more of these five basic steps. For example, labor-saving machinery may be added that increases standby costs but reduces variable costs. The sales mix may be changed and some selected products repriced in order to attain the best profit structure. A production method may be improved, making it possible to decrease labor cost and also dispose of expensive equipment, which would effect a reduction of both standby costs and variable costs.

Conclusion

The profit planning and break-even analysis of a company—whether manufacturer, wholesaler, or institution—can be an invaluable method of analyzing and presenting the facts about cost, volume and pricing—all of which affect profits. These facts are not only more readily recognizable in a simple chart; it is easier to make an objective decision on the basis of a chart than to mentally appraise and evaluate a bulky sheaf of financial figures. In fact, this combination of finance and industrial engineering is another step forward in the field of scientific management.

This article has focused on the planning of profits. The factors necessary to control and measure profits, expenses and sales—such as budgets and sales forecasts—are subjects beyond the scope of this discussion.

Further references

Knoeppel, C. E. and Edgar C. Seybold, *Managing for Profit,* McGraw-Hill, New York, 1937.

Gardner, Fred V., *Variable Budget Control,* McGraw-Hill, New York, 1940.

Rautenstrauch, Walter, and Raymond Villers, *Economics of Industrial Management,* Funk and Wagnalls, New York, 1949.